methods, the *a priori* and the experimental, decided.

Prof. Whitehead sees very clearly and expresses very boldly the philosophical problem of Nature. It is admirably expounded in his chapter on "Theories of the Bifurcation of Nature." By bifurcation he means that Nature is presented first in sense-awareness and then in a conceptual activity of thought. Though the two consequent forms, sense-images and concepts, are inseparable, they are so absolutely distinct that when we reflect on them they present themselves as two totally different kinds, or orders, of facts, between which the relation, so far from being obvious and transparent, is literally incomprehensible. For not only is our sense-awareness fragmentary, requiring an activity of conception to complete it—as when, for example, we conceive another side of the moon—but also the fragmentary appearances themselves are referred to another kind of reality, conceived as existing in itself and called Nature. Physical science treats of electrons, æther waves, and such like, as existent entities, sense-awareness being a special form of the relation of these to the mind. This old philosophical problem has recently forced itself on the attention of physicists by reason of the startling nature of Einstein's special and general relativity principle. In fact, Einstein may truly be said, adapting the famous phrase of Kant, to have roused physicists from their dogmatic slumber. Prof. Whitehead treads the new ground confidently, but yet with caution. He will not have the "curvature of space," and he insists that the concept of Nature shall concern the reality of the observation, unconfused with any question concerning its relation to the observer and his system. To deny the possibility of this detachment is in his view not simple scientific scepticism, but destruction of the basis on which any physical science can be constructed.

(2) The lectures of the late Prof. Royce, originally entitled "Aspects of Post-Kantian Idealism," were first delivered in 1906, and therefore antecede the apparition of the Principle of Relativity. This is not very important, because that principle propounded nothing in the least strange and unfamiliar to philosophers. It is, indeed, essentially one and identical with the principle of idealism. It is its confirmation by experiments which has brought it home with such force to the scientific worker. Although, therefore, the lectures are largely historical, and deal with a philosophical movement and speculation a century old, they are vitally relevant to our present problem. The problem of post-Kantian idealism was essentially the problem of Nature, in particular the fact that while Nature is a concept brought to birth by the mind itself in its intellectual activity, under the stimulus and out of the material provided for it by sense-awareness, yet this concept stands before the mind as necessarily independent and alien in its existence, and as the ground of the existence of the mind itself.

It is curious how, in the historical retrospect of the important philosophical movement which followed Kant, Hegel overshadows all his contemporaries. One of the most interesting portions of this book is the account of the wonderfully brilliant work of Schelling, especially in his early period. No physicist has grappled the problem of Nature with greater zeal or with keener insight than this philosopher.

It is not our purpose to pass judgment, but we commend these two books—both remarkable for their lucidity and intellectual honesty—to all who wish to have a comprehensive grasp of the physical and metaphysical problem of the concept of Nature.

H. Wildon Carr.

The Vehicles of Hereditary Qualities.

The Physical Basis of Heredity. By Prof. T. H. Morgan. (Monographs on Experimental Biology.) Pp. 305. (Philadelphia and London: J. B. Lippincott Co., 1919.) Price 10*s*. 6*d*. net.

So far as the study of heredity means formulating and explaining the resemblances and differences between successive generations great progress has certainly been made, and Prof. Morgan thinks it is mock modesty to refrain from saying that many problems have been solved. The present book is a masterly account of recent work on the physical basis of inheritance, which means, for practical purposes, the chromosomes of the germ-cells. The general evidence in support of the chromosomal theory is once more discussed; its fundamental propositions are clearly stated and abundantly illustrated; and numerous recent subtleties, at varying levels of probability, are explained. The book is indispensable to serious students of biology.

The first general principle is Mendel's law of segregation. The fertilised ovum contains paired factors or genes, causally linked with certain characters; these come into relation to each other, but separate off cleanly in the germ-cells of the offspring, one member of each pair going to one daughter-cell, the other member to the other cell. It is during maturation that the conjugation of homologous (paternal and maternal) chromosomes occurs and is followed by their subsequent segregation. In all probability, apart from hybrids altogether, the germ-plasm of each immature germ-cell is made up of pairs of elements or genes which segregate during maturation. In recent years an entirely unexpected and important discovery has been made in regard to segregating pairs of genes (allelomorphs). In an ever-increasing number of cases it has been found that there may be more than two distinct characters that act as allelomorphs to each other. For example, in mice, yellow, sable, black, white-bellied grey, and grey-bellied grey are allelomorphs—*i.e.* any two may be present (as a pair) in an individual, but never more than two. It may be noted, too, that at an early stage in his argument the author rejects the criticism that Mendelian characters are necessarily superficial characters. He also points out what critics of Mendelism sometimes fail to understand, that species differ from one another, not by a single Mendelian difference, but by many.

Mendel's second law describes the free and independent assortment of the genes. If an immature germ-cell contains the factors or genes—"tall," "short," "colour," "white"—then at maturation the genes "tall" and "colour" (*sit venia verbis*) will go to one daughter-cell, "short" and "white" to the other, or "short" and "colour" to one, and "tall" and "white" to the other. Now the cytological evidence is that each pair of chromosomes, just before the reduction division, consists of a maternal and a paternal member, and there is a free or random assortment of some maternal chromosomes to one pole and some to the other, and similarly for the paternal chromosomes.

But further investigation is disclosing an increasing number of cases in which free assortment does *not* occur. Many characters have been found to keep together in blocks in successive generations instead of assorting freely. This is what is called *Linkage*, one of the post-Mendelian elaborations.

Correlated with the idea of linkage is that of *Crossing Over*, which means an interchange of blocks of genes between homologous pairs of chromosomes. It may be frequent or rare; it may occur in the germ-cells of one sex, but not in those of the other; the size of the blocks may vary at different temperatures and for internal reasons; and a break in one region of the chromosome may interfere with a break in another region. It is altogether very curious and intricate. The genes of a pair do not jump out of one chromosome into the other, so to speak, but are changed by the thread breaking as a piece in front of them or else behind them, but not in both places at once. It is possible that there is a limiting value for crossing over, and if this can be established it may lead to the discovery of the lower limit of the size of the gene. It seems that the crossing over may be effected at the time of the conjugation.

The data in regard to linkage and crossing over lead to the conclusion that the genes are arranged in linear order, standing at definite levels in the chromosomes and definitely spaced. Another interesting suggestion is that the correspondence seen in *Drosophila melanogaster* between the number of linkage groups and the number of chromosomes may hold good generally. Yet another suggestion is to be found in the curious fact, too frequently illustrated to be a coincidence, that one species may have twice as many chromosomes as a closely related one.

In regard to the view that the difference between the sexes is connected with the distribution of particular chromosomes, Prof. Morgan discusses two opposing interpretations. In certain species a female organism develops from a fertilised ovum with two X-chromosomes, while a male organism develops from a fertilised ovum with only one X-chromosome, with or without a Y-chromosome in addition. The question is whether the presence of the two X-chromosomes causes a female to develop, or whether XX is merely an index of sex. According to the author the evidence is now conclusive that sex follows the chromosomes, not the other way round. He shows ingeniously how the chromosome theory of sex may be applied to the interpretation of inter-sexes, gynandromorphs, and allied phenomena.

The conception of a gene or factor seems to become increasingly complex. A gene is to be thought of as a certain amount of material in the chromosome that may separate from the chromosome in which it lies, and be replaced by a corresponding part (and none other) of the homologous chromosome. But it is now becoming clear that a gene is causally associated with *manifold* effects; that different genes may produce characters that are indistinguishable, such as whiteness in poultry; that each character is the product of many genes, and so on. Moreover, the variability of a character is not necessarily due to variability in the gene; much may be due to variability in the environmental conditions of development. Critics of Mendelism must read this book, not necessarily to criticise less, but to criticise more wisely.

There are so many illuminating discussions in Prof. Morgan's book that we find it difficult to stop. Regarding mutations it is pointed out that they are of infrequent occurrence, that the change is definite from the beginning, that some at least are recurrent, and that the difference between the old character and the new is small in some cases and greater in others. But their origin remains obscure. As to their supposed "chance" character, it is pointed out, very usefully we think, that the degree of development of any character increases the probability of further stages in the same direction. Species are to be thought of as groups of genes, and related species have a good many genes in common. Thus similar mutations are likely to occur in different but related species. Of this, indeed, studies on Drosophila have furnished experimental evidence.

We do not know how many books on heredity Prof. T. H. Morgan has written. Their succession marks the rapid advance of a department of science to which his personal investigations have made very important contributions.

New County Histories.

The Victoria History of the Counties of England: Hampshire and the Isle of Wight. Part i., pp. 46+2 maps. Part xv., pp. 409–470+1 plate: *Buckingham.* Parts iv. and vi., pp. 177–205+map and plate. Part xxiii., pp. 312–372+5 plates: *Hertford.* Parts ii. and iii., pp. 43–221+map: *Berkshire.* Part ii., pp. 27–68+map. Part iv., pp. 173–196+map and 12 plates: *Surrey.* Parts i.–iv., pp. 254+4 maps and 2 plates. (London: Constable and Co., Ltd., 1920.) Prices various.

"THE Victoria History," finely conceived and excellent in performance, at the outset in 1900 largely disdained plebeian methods of advertisement. Wealthy country gentlemen were often left in ignorance of its existence, and slender purses were mocked by the high cost to be pledged for the history of any single county. A more considerate policy has now been adopted. Essays by eminent specialists can be purchased separately. Comparison with earlier county histories shows a surprising advance in recognising the importance of natural knowledge.

Since Nature makes merry with man's artificial boundaries, a work taking all our English counties in detail cannot avoid some overlapping and repetition in dealing, for example, with botany and butterflies, with mice and their alliterative contrast, men. The difficulty is enhanced in zoology by the hordes of insects. Records stating when, where, and by whom each species was captured in a particular county become rather appalling. It is a relief to read in the "History of Surrey" that out of 3000 British flies (Diptera) only a miserable tale of 360 can be credited to the county. Yet this luck is "solely due to the paucity of collectors of this order of insects" (p. 151). Though Diptera be few, "the Phytophagous hymenoptera, *i.e.* saw-flies, wood-wasps, and gall-flies, are abundant throughout Surrey." Avoid, however, speaking disrespectfully of saw-flies. "Saw-flies can easily be bred and reared in captivity, and it is only by doing this in large numbers that we can hope to arrive at the laws which control that most mysterious phenomenon, parthenogenesis." Mr. Chawner further declares that a common species, *Poecilosoma puteolum,* produces females only, arguing from the experience that several thousands have been bred for six years in succession, and all turned out to be of that sex (p. 91). Still, it is hard to prove a negative, even for broods to which Sir Ray Lankester's term "impaternate or fatherless" would seem appropriate.

The botanists agree that "the best division of a country for botanical purposes is into river-basins" ("Hertfordshire," Hopkinson, p. 48); to explain the distribution of the flora of Berkshire, "various botanical districts essentially based on the river drainage" are used by Mr. Druce (pp. 29, 51); so also for Surrey Mr. Beeby accepts the division into districts founded on the river-basins "as the most desirable in all respects," with exceptions. The grand exception is, as he explains, that "the geological strata run in such remarkably parallel bands from east to west, while the streams run transversely to them, so that each of the principal rivers has its share of each of the formations." For Surrey Mr. Lamplugh says, "the geological structure of the county is so simple, and its existing features depend so closely upon this structure, that it forms an ideal tract for the study of the elementary principles of the science." The same might be said of the geology of Hampshire as displayed in the late Mr. Clement Reid's luminous treatise. The map of Surrey shows how you may "walk east and west upon the same formation along the line of 'strike' from one end of the county to the other; while if we go southward we soon cross to underlying, and if northward, to overlying beds."

Space permits only bare notice of an important historical disquisition on "Forestry and the New Forest," by Nisbet and Lascelles; and of the profusely illustrated essays on Early and Anglo-Saxon Man in Berks and Bucks by Shrubsole, Clinch, and Reginald Smith; while no attempt can be made to discuss the interesting local history of the "Aylesbury Hundred" of the latter county. In